

Interview with

BOB WEBSTER

Associate Director for Weapons Physics

The new associate director discusses his viewpoints regarding the nature of the science and scientists at the Laboratory... and why he misses using his slide rule.



Recently, Bob Webster was named the Laboratory's Associate Director for Weapons Physics. He oversees the Computational Physics and Theoretical Design divisions, as well as the Laboratory's Advanced Simulation and Computing (ASC) program. The Laboratory's ASC capabilities are inextricably woven into the work of weapons physics and design. Webster recently spoke with *National Security Science* (NSS) about his new role at the Laboratory.

NSS: Where in the evolution of computing did you start your career?

Webster: I think I was in the last class at Case Western Reserve University that used slide rules in the exams. Slide rules were abandoned between my freshman first semester and the spring semester that year; the university *finally* let us use calculators. So initially many of us were still carrying "slip sticks" to engineering classes. That was a different era in terms of how we thought about solving physics problems because we didn't have computers the way we have them now.

NSS: So do you think anything was lost by leaving the slide rule behind?

Webster: I think there was some value in the way that we had to think about the problems when we were still using slide rules, a way that we could reintroduce into the system right now. At the same time, though, there is a tremendous opportunity presented by leaving slide rules behind.

If you look at the last 20 to 25 years, there's a fundamental shift in how supercomputing underwrites our evaluation of scientific problems. In the '70s, supercomputing, or high-performance computing, which wasn't very "high performance" by today's standards, was sometimes viewed as a crutch.

Today it's an integral part of synthesizing theories—we can evaluate very complex scenarios that we can't actually test. For economic, political, and risk factors, we can't always employ the classic, direct scientific experimentation that we were taught to do. I think that's something we need to get out to folks—supercomputing is integral. We can't separate it from doing the experiments and doing the analytic theories anymore.

But there was loss there with leaving the slide rule behind. We started to leave experiments behind more than we should have. Experiments got very expensive, so there's a tendency

to try to compute your way around a problem. If all you have is a slide rule, you must use experiments to inform how you think and reason and internalize the uncertainties and the possibility of error in your calculations.

It's different with a computer—you can run a simulation and get an answer with less consideration of the interplay of the different pieces of physics every step of the way along the solution path. That's a seductive feature of the computer that could bite you. When using a slide rule or a calculator, such considerations couldn't be ignored.

NSS: So one should miss the slide rule because it compelled scientists to approach the experimental process in some very useful and enlightening ways?

Webster: There was a feeling, where I went to school, that higher math was something that required people to learn very complex functions that you could use to represent the solution. The truth of it was, you could only solve problems that were under certain spotlights for those kinds of theoretical approaches. That's something that has changed; you used to have to recast the problem that you were trying to solve so that you could evaluate it with known analytic or semi-analytic solution techniques.

For example, we would frequently have to treat something as spherical when we knew it wasn't, just so we would have a solution technique available. With a computer, one doesn't have to do that. So, we used to get a more exact answer to a more approximate view of the problem, and that has now flipped with the computer. Today, you can actually go get the answer, an approximate answer, to a more exact posing of the problem.

NSS: Do you see a trend away from experimentation because of the economics of it?

Webster: I think there are several factors. It's the economics, but also there's the perceived risk. People can get hurt when they do experiments. We're afraid of that.

If we think about the Stockpile Stewardship Program over the next 15 years, without experiments, how are we going to develop the trust we need to have in scientists?

NSS: Particularly experiments in the Weapons Program?

Webster: It's particularly true in the Weapons Program, but not just the Weapons Program. It's also true in the Energy Program. The Lab used to have a magnetic fusion research division, and we did experiments that were in some cases, by today's standards, perhaps dangerous experiments. Today, the country, and people in general, seem to be less willing to take those kinds of risks. In some cases, that response is justified.

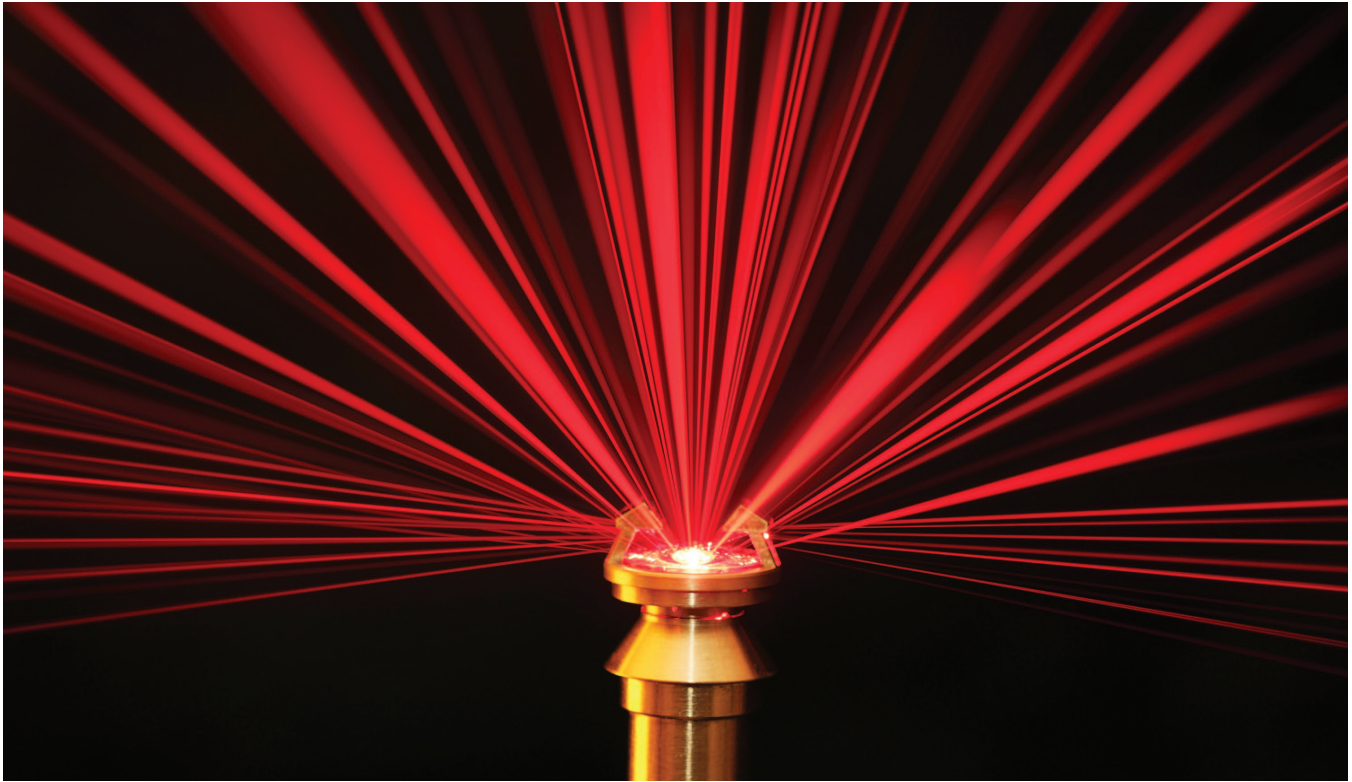


Bob Webster (right) being interviewed by NSS staff in the lobby of the Laboratory's Strategic Computing Center (SCC). The SCC is home to the Laboratory's suite of supercomputers used to solve problems in national security. (Photos: Los Alamos)

For example, we are less willing to do experiments that present risks to the environment. As we've moved that way, a scientist's ability to develop judgment based upon experiments has been diminished. If we think about the Stockpile Stewardship Program over the next 15 years, without experiments, how are we going to develop the trust we need to have in scientists? If we don't expose them to situations where they have to make decisions, and then watch how they react—both when they get the answer right and when they get the answer wrong—how do we evaluate them? How do we know that they're stewarding things well? We need to give scientists the opportunity to pose and solve the types of problems relevant to stewardship.

NSS: It's a conflict. Science is based on taking risks—that's how it moves forward—but at the same time, there's a countervailing weight to be conservative. As an associate director, how do you help manage the two extremes?

Webster: I'm struggling with that a little bit right now. To really have a balance—people developing the self-confidence to make decisions, take the reasonable risks, and develop wisdom but not take imprudent risks—requires a lot more interaction and a lot more opportunity to design something, to create and execute an experiment. It's important to build something, see how it works, and be humbled if *and when* you get it wrong because we're all going to get it wrong sometimes.



In December 2012, Los Alamos and its partners National Security Technologies and Sandia National Laboratories successfully executed a subcritical plutonium experiment in the Gemini series at the underground U1a facility of the Nevada National Security Site. In this experiment, a novel optical diagnostic (shown here) measured the motion of a plutonium surface along more than 100 rays, providing orders-of-magnitude more data than similar past experiments. These data will challenge models of plutonium behavior, ultimately increasing our confidence in the computer simulations that ensure the safety and effectiveness of the nation's nuclear stockpile. (Photo: National Security Technologies)

So I am searching right now within the directorate for different experimental, scientific, and program areas to assign to people to spur them toward these opportunities. I'm looking for an increase in how our folks perform what I think of as "cold physics experiments": moving metal with high explosives. How do I get an active group of people working in that area, whether it's for Stockpile Stewardship or for global security concerns?

NSS: Where do you see your directorate going in the next 5 to 10 years?

Webster: We've got a couple of real challenges that are going to come up within the Stockpile Stewardship Program. There are some changes that are likely to be required for the stockpile that will require active decisions from the Laboratory, including from our directorate. In a number of cases, they won't be easy decisions to make. We want to be certain that if we make a change to a system, the system is going to function.

When we're touching systems on intervals of 30 years or so, we need to remember that industry changes a lot in 30 years.

Clearly, we'll need to increase the amount of computing that we're using. The solution techniques that we have available to us today pretty much demand that we increase the computing that we've got. We'll need that computing power so we can take on the problems we anticipate and be really confident that we have the right answers.

I also see that we're going to have to revitalize a number of components in the experimental programs, partly to get the data to answer the questions we need to answer. Equally important, and maybe even more important, we need to give future stewards the opportunity to experiment, to test themselves against nature, to demonstrate that they're actually capable of predicting what nature will do. That's fundamentally what we are going to be doing.

NSS: Are these challenges being brought on by the age of the stockpile or by changes to components in the stockpile? What's driving these challenges?

Webster: Aging is certainly a concern. Part of aging is the evolution of the manufacturing environment in which we do our work. It's not clear that we can simply rebuild what we have because what we have now was built with a certain set of manufacturing processes. And those may or may not be the processes that we have available today if we need to rebuild a system.

When we're touching systems on intervals of 30 years or so, we need to remember that industry changes a lot in 30 years. The processes we have available to us change. Processes that stockpile stewards will be using to maintain the systems we deploy over the next 5 to 10 years are going to change, too. We have to respond to those realities. We need to have a notion of how we're going to qualify the materials and the parts that are manufactured by the available processes today, so we have a way to monitor them tomorrow through a surveillance program. We also need to know we'll have the skills and capabilities on hand to deal with any issues we find during surveillance.

We challenged our designers to go through the whole process: fielding an explosive experiment and making a prediction—which is an important step when we're developing scientists with good judgment.

NSS: Would you comment on the Laboratory's recent success with the Gemini experimental series in Nevada, which included a subcritical experimental shot?

Webster: That's a good example of evaluating judgment, which goes beyond the good science. That experiment—that

shot—was seen as being a success because we got some data that challenges our thoughts. In fact, we got more data out of that than we ever got from shots of that class in the past. It's remarkable the huge steps that the Gemini experiment represents and the data that came out of it.

But equal to that, and perhaps more important, we benefitted because we challenged our designers to go through the whole process: fielding an explosive experiment and making a prediction—at the risk of looking silly, which is an important step when we're developing scientists with good judgment.

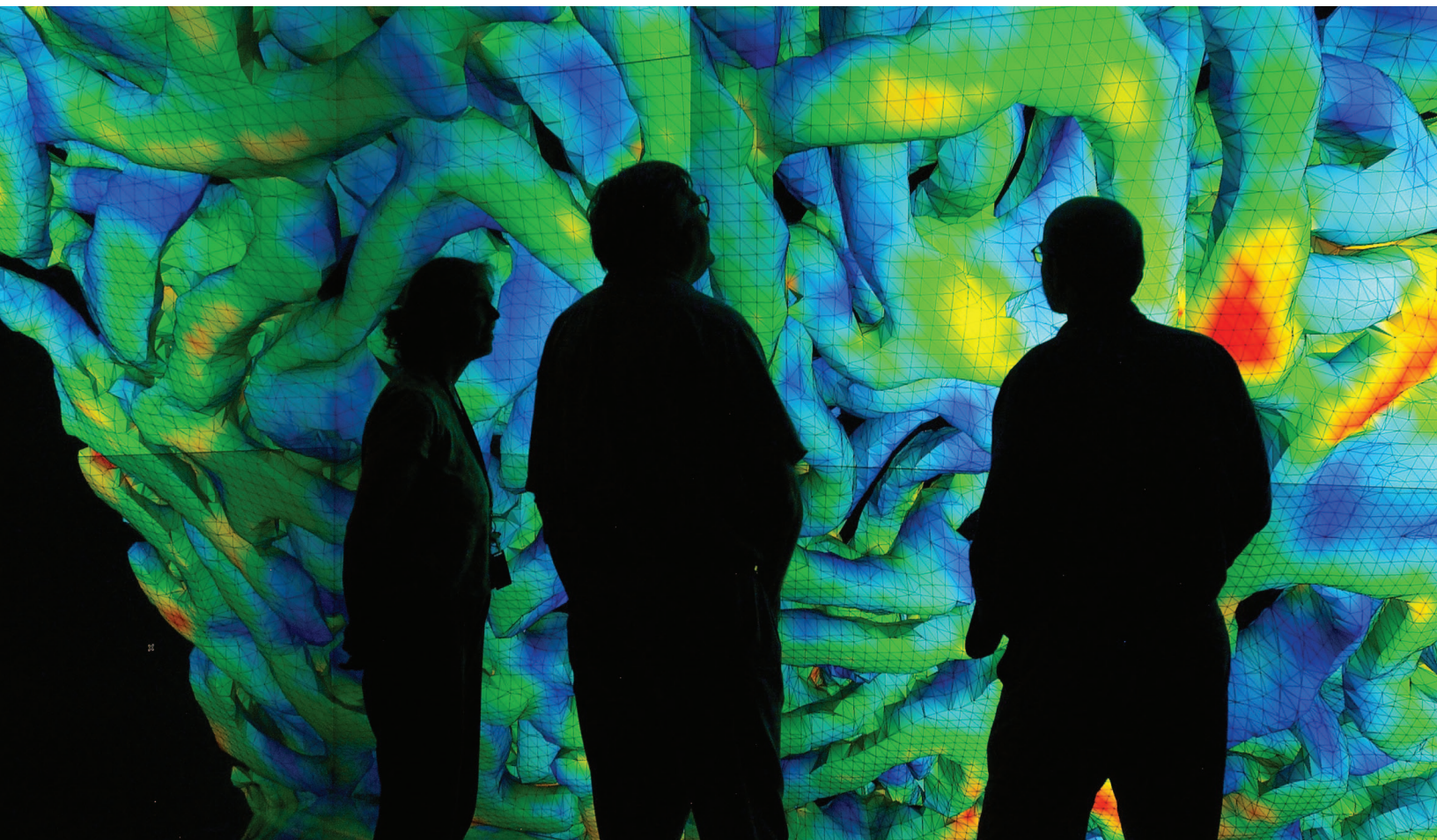
Gemini also tested the judgment of people who assembled the shot. We exercised the entire spectrum of taking plutonium, manufacturing it, shipping it, assembling it, and measuring data from it.

So, we got far more than just science data. We improved the judgment skills of everyone involved—the scientists, the engineers, and the technicians.

NSS: From your perspective, what sort of global security questions might be addressed with supercomputing?

Webster: The global security twist on things throws a wrinkle into the use of high-performance computing in general. In the weapons world, we have fairly exquisite knowledge about what our weapon systems look like and how to construct very high-fidelity computer models of them to understand how they perform.

At Los Alamos, simulations such as those run on Roadrunner and currently on Cielo can be seen as full-color 3D visualizations displayed on a screen or in a viewer-surrounding environment. Visualizations allow scientists to watch dynamic phenomena as they evolve. (Photo: Los Alamos)



In global security, we don't always have that level of detail because we're imagining what *somebody*—a nation or terrorist group, for example—could be doing. In that sense, the high-fidelity driver for predicting their behavior is not so strong. But we still use high-performance computing, for example, if we're trying to predict how a group might use a particular material, given the material's properties, for terrorist activities. So there are aspects of high-performance computing for global security that play a fundamental role, and that could play a *more* fundamental role, in predicting global security threats.

NSS: What kinds of people do you think the Laboratory should be attracting?

Webster: The Laboratory is not sustainable if we don't attract really creative, talented people who know when to take a risk and when to be conservative. When we make stockpile decisions, we need to be conservative, but when we're searching for new solutions to other kinds of problems, we need to be willing to take risks. A person who can balance conservatism with risk is a complicated person to try to find.

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You can be curious. You can go find an expert and learn and have impact on a world-changing scale.

This is a scientist's "place to be."

NSS: How do you convince people to come work for the Laboratory?

Webster: There are very few places in the country or in the world where, if you have a passion for science, you can apply that science to informing, for example, national policy. Weapons research is one such area. Climate research is another.

If you really love science, the Lab is a place where you can come and retool yourself. You can be curious. You can go find an expert and learn and have impact on a world-changing scale as you apply your science. You might not make as much money as you would if you were using those same skills as a quant [a researcher on Wall Street]. They use some of the same scientific techniques to predict financial markets, and you might make a lot of money at it. But if you love basic science and want to have a career as a scientist, the Lab is a place where you can impact the world in a positive way. This is a scientist's "place to be."

NSS: Where has your career at the Lab taken you?

Webster: I started in fusion, and now I'm in weapons. I went from fusion to submarine detection to radar to lasers (doing work related to strategic defense) to oil and gas. At the Lab, you can always find someone who will help mentor and take you through that next transition. It's like being in a library, where you can go to the shelf and find any information you want, but here you pick out a person instead of a book.

When you go around the Laboratory you find that we have enormous bench strength in scientific capability. You can find somebody who can work on or who knows something about almost every different problem. That's an amazing thing.

NSS: Recently, there have been some concerns about the Lab's intellectual integrity because of the current "for profit" business model. As an institution are we compromising our intellectual scientific integrity to a business model?

Webster: That one is actually easy to answer: No. The Laboratory is full of highly educated people who spent years in colleges, which are often fairly liberal places. At those institutions, debate was valued—the open exchange of ideas. We hire people who are selected from that background and training. We have so many scientists here that it would be virtually impossible to compromise the Laboratory's intellectual values. The intellectual, scientific culture here wouldn't allow it.

For a manager, the Los Alamos culture can sometimes be frustrating; managing scientists can be a lot like herding cats. But the upside is that because we're herding cats, it's almost impossible to compromise our intellectual integrity. The staff will speak up; they're not afraid to speak up. That's a huge power here.

Yes, folks will throw arrows at the management. I've been here since 1984, when I first came here as a student. As a scientist, I grew up here. I didn't stay here to get rich, and my value system didn't suddenly change when the contract model changed. That's equally true for all of my colleagues at the Lab. They're all doing this because they believe they're making a difference, with science, for society.

You can find somebody who can work on or who knows something about almost every different problem.

It's frustrating for people like me in management right now, people who have put our lives into doing this. We are getting outside pokes from people who know nothing about the Laboratory but still say, "Oh, you're just doing it for a profit."

That stings. Sure, we're occasionally going to be accused of compromising our intellectual integrity, but that just doesn't happen, not as an institution. Not at Los Alamos. ✦